

WHAT WE CLAIM IS:

1. An optical apparatus comprising:

an observation apparatus having an objective, an
observation optical system unit including a variable
5 magnification optical system, and an imaging optical
system unit including an imaging lens and an eyepiece; and
a fluorescence illumination apparatus removably
attached to said observation apparatus;

said fluorescence illumination apparatus including:
10 a light source;

a reflecting member placed between said objective
and said observation optical system unit at a position
displaced from an optical axis of said objective to make
light from said light source incident on said objective;
15 and

an illumination optical system placed between said
light source and said reflecting member to lead
illuminating light from said light source to said
reflecting member;

20 wherein a first wavelength selecting member for
selectively transmitting light in a specific wavelength
region in said illuminating light is placed between said
light source and said reflecting member, and a second
wavelength selecting member for selectively transmitting
25 light in a wavelength region of fluorescent light emitted
from a sample is placed between said objective and said
imaging optical system unit.

2. An optical apparatus according to claim 1, wherein

said second wavelength selecting member is integrated with said fluorescence illumination apparatus.

3. An optical apparatus according to claim 1,
wherein said second wavelength selecting member is
5 integrated with said first wavelength selecting member.

4. An optical apparatus according to claim 1,
further comprising:

a frame for holding said sample;
a post installed on said frame; and
10 a focusing unit held on said post to change a
distance between said sample and said objective;

wherein said focusing unit holds said fluorescence
illumination apparatus, and said fluorescence illumination
apparatus holds said observation apparatus.

15 5. An optical apparatus according to claim 1,
wherein said observation optical system unit and said
imaging optical system unit are each formed from a pair of
lens units, said pair of lens units being placed in
parallel and symmetry with respect to the optical axis of
20 said objective.

6. An optical apparatus according to claim 1,
wherein said objective, said observation optical system
unit and said imaging optical system unit are each formed
from a pair of lens units, said pair of lens units being
25 placed at a tilt to an axis normal to a surface of said
sample and in symmetry with respect to said axis.

7. An optical apparatus according to claim 5,
wherein said observation optical system unit and said

imaging optical system unit are placed so that a plane containing optical axes of said lens units is displaced from the optical axis of said objective.

8. An optical apparatus according to claim 1,
5 wherein at least one lens unit of the illumination optical system in said fluorescence illumination apparatus is movable so that an illumination area of said illumination optical system is approximately coincident with an
10 observation area that changes in accordance with a magnification changing operation of an observation optical system in said observation optical system unit.

9. An optical apparatus according to claim 8,
wherein said illumination optical system includes:

a collector lens unit for collecting light from said
15 light source;

a first relay lens unit for forming a first image of
said light source;

a second relay lens unit for relaying the first
image of said light source;

20 a first reflecting member provided in said first
relay lens unit;

an aperture stop placed in a vicinity of the first
image of said light source; and

at least one movable lens unit and a second
25 reflecting member provided in said second relay lens unit;

wherein said first wavelength selecting member is
interchangeably provided in said illumination optical
system.

10. An optical apparatus according to claim 1,
wherein a distance between said collector lens unit and
said light source is changed to allow critical
illumination in which a position where an image of said
5 light source is projected and said sample are
approximately coincident with each other.

11. An optical apparatus according to claim 10,
wherein a change in the distance between said collector
lens unit and said light source is independent of a
10 magnification changing operation of an observation optical
system in said observation optical system unit, and a
distance D between said light source and a conjugate
position to said sample closest to said light source in
said illumination optical system satisfies the following
15 condition:

$$|D| \leq 3 \text{ millimeters}$$

12. An optical apparatus according to claim 2,
further comprising:

a mechanism by which said first wavelength selecting
20 member and said second wavelength selecting member are
changed to another first wavelength selecting member and
another second wavelength selecting member, respectively,
in linked relation to each other.

13. An optical apparatus comprising:
25 an observation apparatus having an objective, an
observation optical system unit including a variable
magnification optical system, and an imaging optical
system unit including an imaging lens and an eyepiece; and

a fluorescence illumination apparatus removably
attached to said observation apparatus;

said fluorescence illumination apparatus including:

a light source;

5 a distal end illumination unit placed in close
proximity to said objective; and

an illumination optical system placed between said
light source and said distal end illumination unit to lead
illuminating light from said light source to said distal
10 end illumination unit;

wherein a first wavelength selecting member for
selectively transmitting light in a specific wavelength
region in said illuminating light is placed between said
light source and said distal end illumination unit, and a
15 second wavelength selecting member for selectively
transmitting light in a wavelength region of fluorescent
light emitted from a sample is placed between said
objective and said imaging optical system unit;

wherein said distal end illumination unit is placed
20 at a periphery of said objective so that a center position
of an observation optical system in said observation
optical system unit and a center position of illuminating
light applied by said fluorescence illumination apparatus
coincide with each other on a surface of said sample; and

25 wherein said illumination optical system has at
least one movable lens unit and a moving mechanism, so
that said movable lens unit moves in accordance with a
change in magnification of said observation optical system

to make an observation area and an illumination area approximately coincident with each other.

14. An optical apparatus according to claim 13,
wherein said second wavelength selecting member is
5 integrated with said fluorescence illumination apparatus.

15. An optical apparatus according to claim 14,
wherein said second wavelength selecting member is
integrated with said first wavelength selecting member.

16. An optical apparatus according to claim 13,
10 wherein said fluorescence illumination apparatus
illuminates said sample with light from said light source
through said distal end illumination unit without passing
through said objective.

17. An optical apparatus according to claim 13,
15 wherein said distal end illumination unit has lenses, at
least one lens in said distal end illumination unit being
placed so that an optical axis of said lens is displaced
from an optical axis of said distal end illumination unit.

18. An optical apparatus according to claim 13,
20 wherein said distal end illumination unit includes an
optical member that is formed only from plane surfaces and
that makes incident light emerge therefrom only by a
refracting action.

19. An optical apparatus according to claim 13,
25 wherein said distal end illumination unit includes an
optical member that is formed only from plane surfaces and
that makes incident light emerge therefrom by a refracting
action and a reflecting action.

20. An optical apparatus according to claim 13,
wherein said distal end illumination unit includes, in
order from an illumination optical system side:

5 a first deflection member and a second deflection
member provided in a plane perpendicular to a plane
containing both an optical axis of said objective and an
optical axis of said illumination optical system entering
said distal end illumination unit;

10 said first deflection member deflecting the optical
axis of said illumination optical system;

said second deflection member deflecting said
optical axis deflected by said first deflection member so
that said optical axis extends obliquely to the surface of
said sample in a plane containing the optical axis of said
15 objective.

21. An optical apparatus according to claim 20,
wherein said distal end illumination unit further includes
at least two third deflection members for deflecting the
optical axis of said illumination optical system, said at
20 least two third deflection members being provided closer
to said light source than said first deflection member in
a plane perpendicular to a plane containing both the
optical axis of said illumination optical system entering
said distal end illumination unit and the optical axis of
25 said objective.

22. An optical apparatus according to claim 13,
wherein said distal end illumination unit includes an
optical member having at least two toric surfaces.

23. An optical apparatus according to claim 13,
wherein said distal end illumination unit includes an
optical member having at least one surface that is
asymmetric with respect to the optical axis.

5 24. An optical apparatus according to claim 22,
which satisfies the following conditions:

$$F_y < F_x$$

$$0.8 < (F_y / F_x) / \cos \theta < 1.2$$

wherein θ is an angle formed between the optical axis
10 of the illumination optical system exiting the distal end
illumination unit and the optical axis of the objective;
 F_x is a focal length of the distal end illumination unit
in a direction of a minor axis of an elliptical
illumination area formed on the sample when it is
15 illuminated by an illumination optical system formed from
a rotationally symmetric optical system; F_y is a focal
length of the distal end illumination unit in a direction
of a major axis of the elliptical illumination area, which
is perpendicular to the direction of the minor axis.

20 25. An optical apparatus according to claim 22,
which satisfies the following conditions:

$$|M_y| < |M_x|$$

$$0.8 < (|M_y| / |M_x|) / \cos \theta < 1.2$$

where θ is an angle formed between the optical axis
25 of the illumination optical system exiting the distal end
illumination unit and the optical axis of the objective;
 M_x is a projection magnification of the optical system of
the distal end illumination unit in a direction of a minor

axis of an elliptical illumination area formed on the sample when it is illuminated at the angle θ with a rotationally symmetric optical system, which is obtained by $M_x = I/I_x'$, where I is the sample and I_x' is a sample image formed by the distal end illumination unit; M_y is a projection magnification of the optical system of the distal end illumination unit in a direction of a major axis of the elliptical illumination area, which is perpendicular to the direction of the minor axis, the projection magnification M_y being obtained by $M_y = I/I_y'$, where I is the sample and I_y' is a sample image formed by the distal end illumination unit.

26. An optical apparatus according to claim 13, which satisfies the following condition:

$$0.7 \leq F_{ob}/F \leq 1.2$$

where F is a focal length of the optical system of the distal end illumination unit, and F_{ob} is a focal length of the objective.

27. An optical apparatus according to claim 13, which satisfies the following condition:

$$0.5 \leq S_{ob}/S \leq 1.4$$

where S is a square measure of an area illuminated by the distal end illumination unit, and S_{ob} is a square measure of an area viewed with the objective.

28. An optical apparatus according to claim 13, wherein a region of a lens unit of said objective that is closest to said sample is used as a lens unit of said distal end illumination unit.

29. An optical apparatus according to claim 13,
further comprising:

a frame for holding said sample;

a post installed on said frame;

5 a focusing unit held on said post to change a
distance between said sample and said objective;

wherein said focusing unit holds said fluorescence
illumination apparatus, and said fluorescence illumination
apparatus holds said observation apparatus.

10 30. An optical apparatus according to claim 13,
wherein said observation optical system unit and said
imaging optical system unit are each formed from a pair of
lens units, said pair of lens units being placed in
parallel and symmetry with respect to an optical axis of
15 said objective.

31. An optical apparatus according to claim 13,
wherein said objective, said observation optical system
unit and said imaging optical system unit are each formed
from a pair of lens units, said pair of lens units being
20 placed at a tilt to an axis normal to the surface of said
sample and in symmetry with respect to said axis.

32. An optical apparatus according to claim 13,
wherein said illumination optical system includes:

a collector lens unit for collecting light from said
25 light source;

a first relay lens unit for forming a first image of
said light source;

a second relay lens unit for relaying the first

image of said light source;

an aperture stop placed in a vicinity of the first image of said light source; and

at least one movable lens unit provided in said
5 second relay lens unit.

33. An optical apparatus according to claim 13,
wherein a distance between said collector lens unit and
said light source is changed to allow critical
illumination in which a position where an image of said
10 light source is projected and said sample are
approximately coincident with each other.

34. An optical apparatus according to claim 33,
wherein a change in the distance between said collector
lens unit and said light source is independent of a
15 magnification changing operation of an observation optical
system in said observation optical system unit, and a
distance D between said light source and a conjugate
position to said sample closest to said light source in
said illumination optical system satisfies the following
20 condition:

$$|D| \leq 3 \text{ millimeters}$$